FORCED AND OPTIONAL INTERVALS OF PRESENTATION IN THE SERIAL LEARNING OF NONSENSE MATERIAL

By

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FORCED AND OPTIONAL INTERVALS OF PRESENTATION IN THE SERIAL LEARNING OF NONSENSE MATERIAL*

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A. HISTORICAL

The early experiments of Ebbinghaus (6) on learning showed, among other things, that the items occurring at the beginning of a series and those at the end of the series are learned before those occupying intermediate positions. This phenomenon has been demonstrated again and again by other investigators, as will be shown later in this paper. Various attempts to arrive at the cause of this phenomenon have been made, but the results have all been disappointing. Theoretical analysis has been fruitless. It was felt that there might be some information yielded by an investigation of the time spent on the individual syllables in each presentation of the series, when the subject was permitted to determine that time for himself. It was also felt that a comparison of the primacy-recency phenomenon under the above procedure and under a procedure wherein the timing was automatically controlled might prove fruitful. The following summary of the work on primacy-recency should give some idea of the methods of investigation previously used.

Bingham (1) in his work on memory noted a tendency for his subjects to recall the first and last few items in a series more frequently than the middle items.

Calkins (2) in her work, on the relative recall value of concrete and verbal material, gives tabulations of the results of serial position. Pictures of concrete objects and words were projected on a screen. There were 10 items in each series. Fifty women subjects were used. Recalls were taken immediately and after a delay of two days. The results for position in the series are presented in Table 1.

Calkins' (3) interest in the laws of learning led her to study

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TABLE 1

PERCENTAGES WITH WHICH SYLLABLES OCCUPYING VARIOUS POSITIONS WERE RECALLED

Stimulus	Position in series 1	2	3	4	5	6	7	8	9	10
					Early recall					
Concrete	100	98	100	100	88	96	94	83	83	93
Word visual	100	100	100	90	90	92	92	80	78	76
Word auditory	96	90	92	72	86	90	80	80	72	86
					Late recall					
Concrete	87	83	78	80	63	67	78	76	63	76
Word visual	72	62	44	40	46	36	42	38	46	56
Word auditory	54	32	40	16	44	45	30	38	38	16

From Calkins, M. W.; *Psychol. Rev.*, 1898, **5**, 451-462.

directly the influence of the factors, recency, frequency, and primacy, on paired associates. As material she used color-number pairs, using 10 items to a series and 15 subjects. The items were exposed through a screen and were manipulated by hand. Each item was exposed for four seconds. Each color was to be associated with the number which followed it. Her variation of the factors under investigation was accomplished by using one color twice in each series. In the primacy series the color was presented as the first item of the series followed by one number and then it was repeated later in the series followed by another number. In the recency series it was presented in the body of the series and at the end of the series in each case followed by a different number. The effect of primacy or of recency was indicated by comparing the number of times the number following the color in the recency or primacy position was reproduced, with the number of times the number following the color in any other position was reproduced.

The tests were made by presenting the subjects with the colors and asking them for the numbers which followed them. Each series was exposed once and there was an eight-second rest between presentation and test. Samples of presentation and test series used for primacy and recency and the results follow:

Recency

Presentation series: Peacock—46, *Blue*—38, Brown—51, Grey—74, Yellow—29, *Blue*—52.
Test series: Grey, *blue,* peacock, yellow, strawberry, brown.

Normal response (as blue—38)	25.7 per cent
Recency response (as blue—52)	53.7 per cent
No response	20.6 per cent

Primacy

Presentation series: *Lt. red*—48, Strawberry—13, Violet—60, Grey—82, Orange—29, *Lt. red*—31, Yellow—53, Green—94, Lt. violet—17, Blue—69.

Test series: Strawberry, yellow, *lt. red,* grey, green, blue, lt. violet.

Normal response (as lt. red—31)	20 per cent
Primacy response (as lt. red—48)	27 per cent
No response	53 per cent

W. G. Smith (12) used Müller and Shumann's 10-syllable series in his investigation of the factor of repetition in memory. The subjects read the series in time to a metronome set at 80 or 100, depending on the individual. The subjects, who were cautioned against reading back, read the series 1, 3, 6, 9, or 12 times. They were then asked to recall. The relative frequencies with which syllables in the various positions were recalled with the various number of readings are shown in Table 2.

TABLE 2

Relation Between Position in Series and Number of Presentations

Number of presentations	1	2	3	4	5	6	7	8	9	10
1	81	52	24	16	16	24	26	26	62	84
3	84	67.5	39	38	34	33	29	44	69	92
6	81	61	42	42	34	32	46	54	74	85
9	89	67	49	41	32	33	48	64	77	93
12	92	58	46	41	36	57	57	61	84	91

From Smith, W. G.; *Psychol. Rev.,* 1896, **3**, 21-31.

Welsh and Burnett (13) using unpronounceable nonsense syllables such as *YJV, HXG,* and *HTL* presented series of eight syllables. At an exposure of 60 sigma the total exposure time of a series was one minute "which was kept constant within 1 or 2 seconds by a metronome." The observer was cautioned not to re-read or repeat any syllable after the next syllable appeared. Only one presentation was given and then recalls were taken. The results may be summed as follows:

Position	1	2	3	4	5	6	7	8	Total
Frequency of recall	30	34	37	27	31	29	59	142	384

These authors suggest that in many cases the high value for primacy is obtained in techniques in which recency, frequency, vividness, and primacy, are being investigated together, and quote an earlier, unpublished Bedford experiment by Lamb. Lamb used eight series of eight syllables each. One syllable was presented twice to give frequency. Vividness was presented by colored paper and pictures pasted besides the syllable. In the course of the experiment every syllable but the last was treated in this manner. Welsh and Burnett suggest that the primacy results of Lamb are brought about by the frequency with which the first syllable was used as a carrier for frequency and vividness. They also suggest that where primacy is shown to have high value the subject is permitted to think backward.

Finkenbinder (8) among his conclusion states that the initial and final syllables of a series are the first to be learned. Finkenbinder was investigating the curve of forgetting. He gives us no data on primacy or recency.

Robinson and Brown (11) investigated the order in which items occupying the various positions in a series of nonsense syllables were learned. They obtained data for each presentation after complete learning. They used series of 6, 9, 12, 15, and 18 syllables and also series of 4, 6, 8, and 10 three-place numbers. They used the anticipation method. The series were presented at intervals of two seconds and after the first presentation of the series the subjects were asked to anticipate the second syllable after seeing the first, the third after seeing the second, and so on. They had to anticipate the syllable before it appeared. The syllables were spelled, not pronounced. Ten subjects were used, each learning six series of each length. The data unfortunately are presented in curves. No results are presented on the first syllable as that was used only as a cue to indicate which series was called for.

The general conclusions were:

> The effect of both primacy and finality (recency) are pronounced. Primacy is a consistently stronger factor than finality. Primacy effects more factors than does finality. The individual curves for each item take the usual form of the learning—when plotted against number of presentations on

the abscissa and percentage of correct recalls on the ordinate.

There seems to be no reason to doubt that the first and last members of a series are learned before the middle ones, although there is a question as to whether the effects have been over or under estimated. The best of the experimental work, that of Robinson and Brown, is rather conclusive, that of Welsh and Burnett measured retention rather than primacy. Of the experiments reviewed on the subject only two fail to show clear cut evidence of this phenomena. The Welsh and Burnett investigation shows no evidence of primacy, but good evidence of recency. Perhaps the use of unpronounceable syllables of unequal difficulty and the 62 sigma exposure interval, which was too short, may account for this. The results of the Calkins' (3) experiment are definite and conclusive as to recency but not significant as to primacy—unequal difficulty of pairs and the lack of complete learning may account for some of her results. The influence of the subject's knowledge of the problem to be investigated is probably a factor in every case, as are the instructions under which the subject learns.

Although many experiments have been carried out to determine the most advantageous speed of presentation for serial nonsense material, the techniques were so varied and the results so conflicting that the present author was led as much by convenience as by the literature to the use of a forced presentation interval of one second. The present analysis of the free time interval is in part anticipated by two previous investigations—those of Kühn (9) and Meumann (10).

Meumann says:

> I performed the following experiment. . . . The revolving drum which carried bands of nonsense syllables was provided with a crank so that it could be rotated by the learner at whatever rate he chose. . . . Our results show that the drum was rotated very slowly at first, much more slowly than in the ordinary experiments with syllables . . . then the rate increased with periodic acceleration and retardation until . . . the learner chose an exceedingly rapid rate of reading.

We were unable to examine Meumann's data as this general work (*opus cit.*) did not go into detail and gave no reference as to where,

if anywhere, these results were given more completely. Search of Meumann's other publications was also unfruitful.

The experiment of Kühn may be quoted in some detail. Kühn investigated the problem of fixed versus free timing. His major problem was that of the influence of recall in the learning process. He used connected and non-connected, meaningful and nonsense material. The timing in the fixed presentation was controlled by means of a metronome at 92 clicks per minute which gave 1.65 seconds to each word or syllable. The lists were 12 syllables long and were arranged by Rupp according to Müller and Shumann. They were presented simultaneously. A two-beat pause was put between each reading of the series.

The subjects were cautioned against reading backward. The word lists were made up with care to avoid association or connection between the items. The connected material was tercets from Chamisos' poems—this was iambic and each accented syllable fell on a metronome beat. A two beat rest was inserted between each reading. Nineteen subjects learned four series at each sitting and the twentieth learned six series at each sitting. Four to six subjects were used in each variation of the technique. Kühn concludes that learning with free timing is better than learning with controlled timing whether the material is meaningful or nonsense, connected or non-connected, and with or without recitation.

The Meumann experiment led Fineman and Ruderman (7) to investigate the relative value of constant presentation speeds with a controlled speed which was varied systematically.

The constant speeds of one syllable to .50, .60, .75, and 1.00 seconds were compared with the variable speed in which the first presentation was one in 1.00 second; the second .75, the third .60; and the last .50 seconds. The "treffer method" was used and tests were made after four presentations. There were two subjects, the authors, who were also the experimenters. A Spindler and Hoyer exposure apparatus was used. There were 10 nonsense syllables in a series and four spaces between each presentation. The results for the two subjects are shown in Table 3.

It is interesting that the length of time spent on the variable speed, 28.5 seconds lies almost midway between that spent on the .60 and .75 speeds, and that the values for the percentage of correct response and one of the two in percentage divided by time for learning also

TABLE 3
COMPARISON OF CONSTANT AND VARIABLE SPEEDS

Speed	Percentage correct responses		Time for learning	Percentage time for learning	
	*F**	*R*		*F*	*R*
1.00	.800	.540	40	.0200	.0135
.75	.700	.440	30	.0259	.0147
.60	.692	.412	24	.0288	.0171
.50	.568	.348	20	.0284	.0174
Variable	.704	.444	28.5	.0247	.0156

**F* and *R* = subjects.
From Fineman and Ruderman: *Amer. J. Psychol.*, 1924, **35**, 261-263.

lie there. The other is displaced one interval toward the slower time.

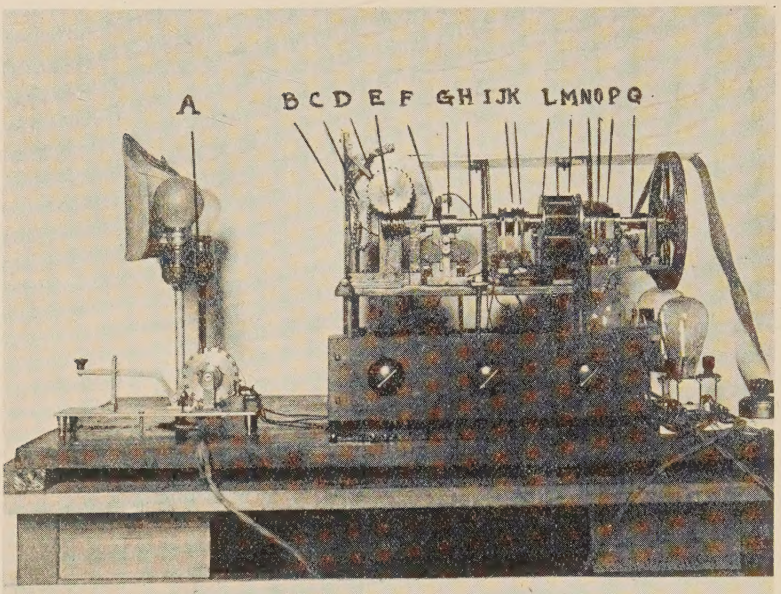
None of these experiments reviewed was directed toward determining the interrelation between subject-controlled presentation time and recency-frequency phenomena as is the present work.

B. APPARATUS

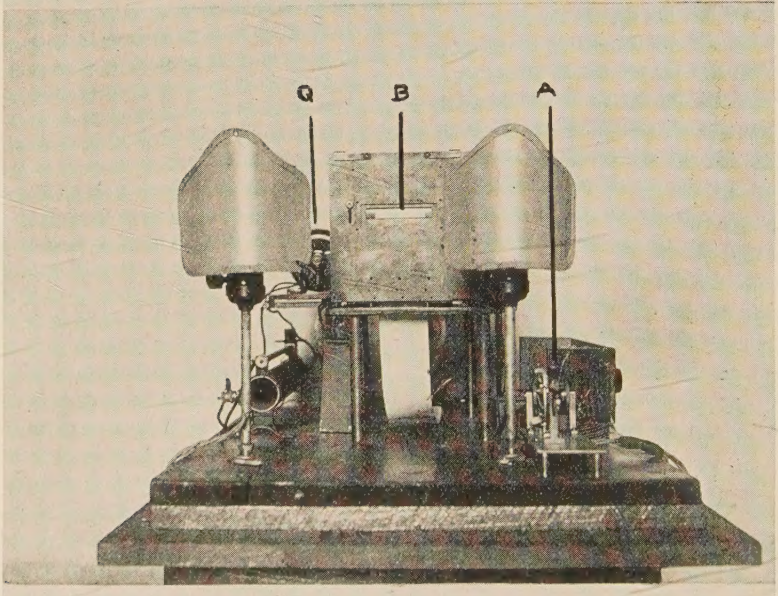
The exposure apparatus used in this investigation was designed by Dr. Knight Dunlap. It may best be described by referring to Figure 1.

The motor *Q* turns the shaft *P* to the end of which are attached the clutch magnets *M*. These act upon the clutch plate *L* and then turn the shaft *H* carrying a worm *E* with which meshes the worm wheel *D*, mounted on the same shaft as the exposure drum *C*. *N* and *O* are collecting rings which carry current to the clutch magnets *M*. *G* is a combination brake stop and contact maker. *F* is a dog carried on the shaft *H*. *I* is a collecting ring and *J* and *K* are 180° commutators.

The brake stop *G* in its normal position rests against *F* and prevents shaft *H* from revolving. When it is drawn back it closes two contacts not shown in Figure 1. Closing these contacts sends current through collecting ring *I* and through commutator *J* to the collecting ring *N*, through clutch magnets *M* and back to the power source through *O*. When the clutch magnets are energized they pick up clutch plate *L* and cause it to revolve carrying with it shaft *H* and the drum *C*, after about 10 degrees of rotation of shaft *H*, commutator *K* short circuits the contacts behind brake *G* and so



SIDE VIEW



FRONT VIEW

FIGURE 1

even though the brake moves back to normal position the shaft *H* still continues revolving. After 180 degrees of rotation commutator *K* runs off the brass and the machine continues the rest of its motion by inertia and finally is stopped by *F* coming up against brake *G*.

The brake *G* is electromagnetically controlled. It is kept in its normal position by a spring and is pulled back into starting position by an electromagnet.

During this experimentation the motor was turning at such a speed that 110 to 170 sigmas were required by the apparatus to complete a turn. One turn of the shaft *H* causes the drum *C*, which is geared to it, to turn a distance equal to the triple spacing on a standard typewriter. The series of nonsense syllables were placed on the drum, on a long strip of paper, and were exposed to the subject through a hole in the screen *B*. Only one syllable could be seen at a time.

The operation of this exposure apparatus requires that the brake electromagnet shall be energized long enough for shaft *H* to revolve about 10 degrees but not so long that a complete revolution can take place. In order to fulfill these requirements a special contact switch was devised by Dr. R. M. Dorcus (4) (A in Figure 1). This key answered the requirements for the optional procedure and was operated by the subject.

For the forced presentation the special contact key was replaced by a relay which in turn was driven by a mercury contact seconds pendulum.

A four-pen polygraph was used to record the intervals which the subjects used. The first pen was connected to the seconds pendulum, the second pen to a vibrating reed making 10 contacts per second, the third pen was in series with the subject's key, and the fourth with commentator *K* on the presentation apparatus. This fourth pen was used because it was possible for the subject's key to be depressed so quickly that the machine could not respond.

The opening below screen *B* was closed during experimental periods so that the subject could not see the strip of nonsense syllables which is visible in the front view of Figure 1.

C. Material

A list of 376 nonsense syllables was prepared and submitted to

TABLE 4

FORM SUBMITTED TO SUBJECTS ON BASIS OF WHOSE REACTIONS FINAL ELIMINATIONS WERE MADE

RAB	PEZ	BER	FEG	MOF	CEF	KEF	DUP
DEC	LUP	YOK	ZUP	GID	KAZ	FUG	WEK
GUK	JOM	REL	TOL	YAF	PIB	DOP	KIR
WAM	YOZ	YIF	GER	FIK	FOD	NAR	FOL
TEB	BAM	JOP	LEK	ZOD	YEM	LER	WIM
MIZ	SUL	SOG	BOP	YUD	JAL	BUP	ZAK
ZAM	JIR	GAN	SIF	YEF	SUF	DAK	TEP
JUM	MEB	ZAF	ZEM	LIN	WEP	ZEB	TOD
YOP	KIF	SIM	JAF	GIR	LIF	JIF	KUG
GAK	GUD	WUF	TUD	WEF	MIG	KOL	RIN
NER	ZAR	YAL	RAK	ZIM	ZEK	KUN	SEP
FUT	TIG	NIM	DEP	SEG	WAF	LIR	BAF
PIR	LAR	YEK	WAK	TAF	NIF	RON	YAD
KET	BOD	NAZ	DAR	JOL	GUR	SER	BEK
FOK	ZIK	REB	FIP	YOB	BOZ	JIZ	ZOL
BEF	JUP	GED	GOZ	ZAG	YAT	LAN	PEM
GUP	RIL	FID	TUK	FEK	FUP	KEL	GIK
KIG	SEF	ZUG	TIB	WIP	JID	BOR	SEN
DUF	BEM	DUT	LOF	SIG	TEK	LEF	ZEP
BAK	GIZ	YUF	GEP	NIZ	SAR	DOR	MOD
YOD	MOR	ZOB	BUF	NOF	YUK	BUK	DIB
SEB	FET	WEZ	WOB	BEP	GEB	ZOF	WOF
TIF	WUM	PAM	ROK	FAK	LIG	YAB	REG
ZEL	TER	KIB	KER	NUG	DOB	MEP	TAL
JIK	JOD	TOK	MIB	WEM	BIK	GAM	SOR
WUL	ZAD	RIT	SUG	JAD	ZON	ZAP	YIM
MEF	NEM	PAB	LOM	TAK	ZIG	LEP	KEZ
BUR	FAP	MIK	ZEG	RUL	RAF	WUP	FUD
SAZ	ROF	YIT	SOF	BAP	YED	FOM	MAF
WUB	JER	NEG	MIP	GIF	DEZ	GOL	DAL
DAP	GUB	FIM	SUT	POR	NIR	YIR	ZIR
MOG	RIK	YOR	JUK	MEK	POB	ROP	DUR
RAL	DAG	REN	TAZ	ZID	FAL	JEG	YIB
RUK	WOR	JOR	REZ	NAL	TEF	RUP	ROG
JEP	SUK	LAT	GAF	MOZ	SEL	YIG	NUK
DIZ	TUL	RAD	LEB	SUD	BAZ	MER	KEP
YOT	YAN	WUK	NOL	NAF	JUR	KOR	PEB
KEB	SAF	BIR	PAG	BIP	WOK	BIM	LUD
NAD	FEP	ZAL	LOD	TEM	RUD	NUD	WAB
LOR	BOM	BEZ	ZIL	WOD	ZIT	TEG	ZET
SOM	PIM	ROM	WUD	JEK	TOB	ZAN	POK
PEL	WOM	PUD	YOL	WIB	NUP	GOR	POG
WOG	GEK	NAK	PAF	ZUK	YIL	ROZ	WER
JUB	LUB	BOF	FUB	MIF	LUR	PEF	DAF
LAZ	ZAB	ZIB	GIB	LUT	GOM	NAM	LIB
FON	PID	YUT	NER	KEM	MEL	LON	WOL
PUM	NUM	GIM	WUG	FAB	POF	ZER	GOK

16 graduate students in the Department of Psychology at the Johns Hopkins University. In preparing this list all syllables difficult to pronounce were omitted as were all those which spelled English words. All syllables which became English words if slightly mispronounced were also omitted. Table 4 shows this list. The instructions for marking it, which were placed on the bottom of the sheet, read as follows:

> Please put a check mark after each syllable which you would tend to pronounce like any significant word. Also put a plus-mark after each syllable which has, rather immediately, a definite verbal association. If the association occurs with notable promptness, put two plus-marks after the syllable. Sign your name.

The three types of response were separately tabulated and all syllables to which word response had been made were eliminated. This left a total of 141 syllables. The associations made to these 141 syllables were distributed as follows:

Number of associations	Number of syllables
0	30
1	31
2	37
3	16
4	6
5	9
6	3
7	4
8	3
9	2

Eight series of 12 nonsense syllables each were made of the syllables of the first three classes. These were the experimental series on which results are reported. They are shown in Table 5. Each of these series had an association value of 12, and had, as nearly as possible, the same number of syllables of each class.

Three series were learned by each subject before any records were made in order, that the subjects could familiarize themselves with the apparatus and procedure.

In making the experimental and preliminary series Müller and Shumann rules were used as far as possible, but with so few syllables

TABLE 5

EXPERIMENTAL SERIES—12 ASSOCIATIONS EACH SERIES

Series							
A	B	C	D	E	F	G	H
JID	YED	LEB	TEG	YAF	NIM	ZEB	ZAL
ZOF	TAZ	GUK	PID	KEB	YAD	NAZ	MEP
MIB	FUD	TEP	MEF	YIM	TEB	KEF	FID
TEF	YEM	MAF	YIL	FEP	GAK	JIZ	YEK
YAN	WUP	ZEM	GED	TUD	FIM	YUT	GUB
KIB	NAF	WAB	ZAF	ZIB	YUK	SEB	REZ
GEP	ZIK	YEF	KUG	GEF	ZEG	ZIR	JOD
YIF	DEZ	PAB	ZAN	WIB	JIK	WEM	SEF
WOG	BOF	FEK	YIG	ZUK	PAF	FUB	ZUG
PIB	MIG	YIB	JUK	PEF	ZOL	ZIM	NEM
FEG	ZAB	JAF	FIP	JAL	WEF	GEK	WUB
ZOB	FIK	ZID	YUF	MEB	BAZ	WUG	KEZ

to select from it was necessary to modify the rules in several cases.

D. PROCEDURE

The original procedure under both methods of presentation required the subjects to recall the series after each presentation after the third. If the recall was not perfect the series was again presented and this was continued until a perfect recall was made. After the first four series had been learned and it was found that one or two subjects had learned a series in seven presentations, it was decided to put the recalls after each presentation but the first in order to avoid possible over-learning and to obtain data on serial position.

The instructions to the subjects under the optional procedure were:

> This is a problem in serial learning. You can see through the slot three stars. As you press the key they will be replaced by a nonsense syllable which in turn upon your pressing the key will be replaced by another nonsense syllable and so on. When you have finished the series three stars will again appear. This is to indicate to you that you have finished the first presentation of the series and are starting on the second presentation. Do not stop between presentations of the series. You are to press the key at the speed which will just enable you to read the syllables clearly but not give you the time to study them. Do not review previous syllables; attend only to the syllable present before you on the machine. Your problem is

to learn the series presented as quickly and with as few repetitions of the series as is possible. (1) Do not think back over previous syllables. (2) Do not anticipate syllables to follow. (3) Spend only enough time on each syllable to read it clearly —enough to study it. (4) Continue until told to stop.

The instructions under the forced procedure were:

This is a problem in serial learning. You can see through the slot three stars. After a short interval they will be replaced by a nonsense syllable which in turn will be replaced by another nonsense syllable and so on. When the series is finished three stars will appear. This is to indicate to you that you have finished the first presentation and are now beginning the second presentation of the series. There will be no stop between repetitions of the series. Do not review the previous syllables; attend only to the syllable present on the machine. Your problem is to learn the series presented with as few repetitions of the series as is possible. (1) Do not think back over previous syllables. (2) Do not anticipate syllables to follow. (3) Continue until told to stop.

The instructions for the recalls were:

Recall the series in as near the order in which it was presented, as possible. If you are not sure of the position of an item, give it where you think it belongs.

The subjects were permitted to take as long as they needed to recall while the experimenter wrote down the series as they were dictated. The time taken by the subject was recorded. Ten seconds after the subject had indicated he was through the next presentation was started.

One week after the series had been learned, the subject attempted to recall it after being shown the first syllable. He then relearned it. A recall was taken after each presentation during the relearning.

The subjects used in this experiment were as follows: 11 graduate students in the Department of Psychology of the Johns Hopkins University, one Instructor in Psychology, one senior in the College of Arts and Sciences, and one special student pursuing courses in psychology. These subjects were divided into four groups. These groups learned the eight series in the order shown in Table 6.

TABLE 6

GROUPING OF SUBJECTS

Group 1 Series	Method	Group 2 Series	Method	Group 3 Series	Method	Group 4 Series	Method
E	Optional	A	Optional	E	Forced	A	Forced
F	Optional	B	Optional	F	Forced	B	Forced
A	Forced	E	Forced	A	Optional	E	Optional
B	Forced	F	Forced	B	Optional	F	Optional
C	Forced	G	Forced	C	Optional	G	Optional
D	Forced	H	Forced	D	Optional	H	Optional
G	Optional	C	Optional	G	Forced	C	Forced
H	Optional	D	Optional	H	Forced	D	Forced
Number of subjects	4		3		3		4

E. DISCUSSION OF RESULTS

The individual results on order of learning are presented in Tables 7 to 10 for learning and 11 to 14 for relearning. In arriving at these scores each syllable was given a score corresponding to the number of the presentation after which it was always recalled correctly and in place.

When the order of learning the syllables occupying each position is compared on the basis of Tables 7 to 10 there seems little difference, and that not consistent, between the forced and the optional procedure. In every case the earlier syllables are learned first (the effect of primacy) and the final syllables are usually learned after the first syllables but before the middle ones (the effect known as recency). These results are similar for all subjects whether they learned more quickly by the forced or by the optional method. The above results also hold for relearning as shown by Tables 11 to 14.

These findings are further illustrated by Figures 2 to 5 which are fair samples of the performance of all subjects. Each of these graphs is based on the learning or relearning of four series by one subject. The figures on the ordinate are obtained by dividing the number of presentations required to learn the four syllables which occupied each position by the total number of presentations required to learn the four series. The figures along the abscissa show the position in the series.

Table 15 shows that nine subjects learn more quickly with the

TABLE 7

NUMBER OF PRESENTATIONS AFTER WHICH SYLLABLES OCCUPYING VARIOUS POSITIONS WERE ALWAYS CORRECTLY RECALLED (Group I)

Position	Optional Series E	F	G	H	Forced Series A	B	C	D	Optional Series E	F	G	H	Forced Series A	B	C	D
	Subject 1								*Subject 2*							
1	4	4	3	2	4	4	2	2	4	4	2	2	6	4	2	2
2	4	4	3	3	5	8	2	2	5	5	2	4	8	7	2	8
3	7	6	6	3	4	7	10	3	9	9	3	5	9	5	3	6
4	5	7	7	5	8	9	18	4	15	9	3	5	10	6	2	7
	13	6	3	9	8	18	6	10	11	4	4	4	10	5	11	
6	18	14	3	3	20	8	9	4	6	5	4	5	4	10	5	2
7	19	13	9	2	20	10	15	4	13	11	7	2	5	6	6	10
8	20	11	9	8	20	9	7	4	4	4	6	3	8	8	5	2
9	18	9	7	8	5	9	8	8	7	8	11	7	5	6	7	10
10	15	13	9	5	9	5	17	7	16	5	9	5	7	8	5	5
11	10	13	5	3	8	6	9	7	9	6	7	8	9	10	9	2
12	5	4	3	2	10	6	2	9	9	4	8	8	6	8	4	6
Presentations	20	14	9	8	20	10	18	9	16	11	11	8	10	10	9	11
	Subject 3								*Subject 4*							
1	4	4	2	2	4	4	2	3	4	4	4	2	14	4	4	3
2	4	4	2	2	6	4	3	4	9	5	4	2	8	4	8	4
3	4	4	6	2	6	11	4	4	11	8	6	2	9	4	3	5
4	5	6	5	3	15	8	5	5	14	9	3	3	11	4	2	5
5	8	8	2	4	7	10	6	7	7	13	6	5	8	5	9	6
6	9	7	3	3	8	5	6	5	9	13	7	5	15	5	12	6
7	6	5	9	2	19	6	9	5	8	14	8	5	15	7	12	6
8	13	12	9	4	18	5	11	5	11	13	8	5	13	6	11	3
9	17	7	8	6	15	7	11	8	12	13	11	6	10	7	7	8
10	12	5	5	5	17	8	12	10	8	5	10	4	10	8	12	8
11	8	5	4	4	16	4	4	3	8	6	9	3	10	7	13	5
12	5	5	3	2	4	6	4	3	6	5	7	4	10	5	11	3
Presentations	17	12	9	6	19	11	12	10	14	14	11	6	15	8	13	8

optional procedure when measured by presentation, four when measured by time, and three by either method of scoring. Comparative study of Tables 15 and 17 shows there is no consistent relation between the superiority of either method of presentation, when measured by time, and the correlation of the average length of exposure interval, used in each position, with the order of learning.

When a similar comparison is made on the basis of number of presentations we find subjects with high, low, and no correlations all showing superiority.

TABLE 8

NUMBER OF PRESENTATIONS AFTER WHICH SYLLABLES OCCUPYING VARIOUS POSITIONS WERE ALWAYS CORRECTLY RECALLED (Group II)

Position	Optional Series A	B	C	D	E	Forced Series F	G	H	Optional Series A	B	C	D	E	Forced Series F	G	H
				Subject 5								*Subject 6*				
1	5	4	4	6	4	4	2	2	18	5	4	2	4	4	2	4
2	9	4	3	6	13	5	14	4	22	5	6	6	9	9	3	6
3	7	7	5	4	6	6	6	4	18	4	11	6	4	9	7	4
4	12	8	7	7	10	10	10	7	22	6	7	4	9	6	9	4
5	6	13	9	5	10	15	5	7	22	6	12	7	5	7	7	5
6	10	11	8	9	6	18	5	4	23	7	9	7	8	10	8	6
7	14	14	12	7	12	19	5	3	24	12	9	7	9	11	4	3
8	15	17	17	6	13	21	11	11	25	10	9	6	6	9	10	3
9	8	20	14	10	10	13	13	8	26	6	13	7	9	6	5	4
10	19	18	11	7	6	7	9	2	24	10	18	6	6	8	8	5
11	14	19	8	7	5	5	12	7	18	5	17	8	4	5	8	4
12	12	10	8	7	4	4	12	3	17	5	15	7	5	4	4	7
Presentations	19	20	17	10	13	21	14	11	26	12	18	8	9	11	10	7
				Subject 7												
1	5	4	2	2	4	4	3	2								
2	12	4	3	2	4	12	4	2								
3	4	5	3	2	4	5	8	4								
4	6	5	4	2	17	12	6	7								
5	4	7	4	4	7	4	5	6								
6	16	8	6	4	14	5	7	7								
7	19	9	13	7	24	10	6	7								
8	19	14	11	4	19	11	5	7								
9	18	13	11	8	26	10	8	9								
10	18	13	13	6	20	5	9	10								
11	20	13	11	7	4	7	8	10								
12	8	13	8	7	4	5	6	5								
Presentations	20	14	13	8	26	12	9	10								

Table 6 shows that in comparing learning by forced and optional control of presentation intervals, we are comparing the total of the first and last two series learned with the total of the middle four series learned. In order to determine what effect this procedure alone might have, the average scores for the four series of these two divisions were compiled for the total group of subjects. They are as follows:

TABLE 9

NUMBER OF PRESENTATIONS AFTER WHICH SYLLABLES OCCUPYING VARIOUS POSITIONS WERE ALWAYS CORRECTLY RECALLED (Group III)

Position	Optional Series A	B	C	D	E	Forced Series F	G	H	Optional Series A	B	C	D	E	Forced Series F	G	H
	Subject 8								*Subject 9*							
1	9	4	3	4	5	4	3	2	8	4	2	2	14	4	4	2
2	7	4	3	3	11	4	3	2	4	5	3	10	16	8	3	5
3	7	5	4	4	7	8	6	3	4	6	8	3	8	4	5	4
4	9	5	7	5	13	9	5	4	4	7	5	5	12	8	3	7
5	6	7	7	6	15	10	7	6	6	10	8	6	16	11	7	7
6	12	4	10	7	16	12	8	6	9	11	10	8	19	18	10	6
7	12	4	11	5	15	11	8	7	8	10	11	3	12	19	9	7
8	10	7	11	5	12	12	6	6	6	7	7	4	10	9	10	5
9	4	6	11	5	14	7	6	5	5	13	6	9	8	7	7	8
10	7	6	8	5	14	11	6	5	9	8	2	4	8	5	7	4
11	11	7	2	4	7	4	3	3	8	5	2	4	6	4	7	6
12	6	4	3	3	5	5	3	10	5	5	4	7	14	4	2	5
Presentations	12	7	11	7	16	12	8	10	9	13	11	10	19	19	10	8
	Subject 10															
1	6	8	2	3	11	4	8	2								
2	6	4	6	2	10	4	9	4								
3	16	4	4	2	15	4	3	2								
4	6	4	7	3	14	4	6	3								
5	4	4	10	3	8	11	6	6								
6	7	7	3	6	12	11	7	3								
7	12	9	5	5	13	8	3	5								
8	8	9	5	5	9	9	7	5								
9	12	15	6	5	16	8	9	7								
10	9	12	9	6	14	13	4	10								
11	14	11	8	7	12	9	8	6								
12	10	10	10	7	12	9	6	4								
Presentations	16	15	10	7	16	13	9	10								

For Time	
First two series and last two series	674.4 sec.
Middle four series	656.4 sec.
Difference	18.0 sec.
For Presentation	
First two series and last two series	55.6 pres.
Middle four series	46.7 pres.
Difference	8.9 pres.

TABLE 10

NUMBER OF PRESENTATIONS AFTER WHICH SYLLABLES OCCUPYING VARIOUS POSITIONS WERE ALWAYS CORRECTLY RECALLED (Group IV)

Position	Optional Series E	F	G	H	Forced Series A	B	C	D	Optional Series E	F	G	H	Forced Series A	B	C	D
	Subject 11								*Subject 12*							
1	4	6	2	2	4	12	2	2	4	4	2	2	11	4	2	4
2	16	8	6	3	4	16	7	2	4	4	3	5	6	4	5	6
3	4	8	7	3	9	4	14	2	4	4	4	6	9	7	2	5
4	20	14	9	4	21	18	5	3	5	6	3	6	9	5	2	4
5	17	9	5	7	27	5	8	6	6	7	3	4	8	4	6	7
6	22	12	5	6	24	10	19	7	6	7	6	6	10	6	5	6
7	18	15	8	6	22	21	11	11	5	4	3	4	11	6	7	6
8	19	16	10	9	20	14	26	4	4	4	3	4	11	6	6	3
9	22	13	11	9	20	10	2	14	5	5	4	4	6	6	9	3
10	20	16	11	4	27	20	24	22	5	4	5	5	7	7	8	6
11	20	6	11	6	17	25	6	23	5	7	4	5	10	7	7	5
12	16	8	12	3	21	27	5	23	4	7	4	5	6	4	3	3
Presentations	22	16	12	9	27	27	26	23	6	7	6	6	11	7	9	7
	Subject 13								*Subject 14*							
1	4	4	3	3	8	4	4	2	5	4	5	2	6	5	5	3
2	9	5	3	3	10	9	5	10	5	4	3	3	13	12	2	3
3	4	4	11	3	9	4	4	3	5	7	11	5	9	19	8	3
4	9	5	11	5	16	11	3	5	8	13	11	8	9	13	10	2
5	10	4	11	5	6	10	6	6	4	5	3	8	7	9	8	11
6	10	4	11	7	17	17	6	8	14	17	3	11	9	6	11	14
7	10	6	11	8	20	14	8	3	18	14	10	13	19	13	9	13
8	10	6	6	7	20	10	10	4	9	13	5	12	15	16	11	13
9	10	7	7	6	16	10	10	9	11	7	12	13	18	18	13	19
10	11	7	11	5	15	16	7	5	14	4	9	2	18	18	13	17
11	4	6	5	5	17	16	6	4	6	4	8	6	20	10	8	10
12	4	5	4	5	10	15	6	7	4	4	3	4	7	7	7	11
Presentations	11	7	11	8	20	17	19	10	18	17	12	13	20	19	13	19

If the subject records as given in Table 15 are studied with this in mind we may readily see that in so far as time superiority is concerned, the difference of 18 seconds for four series is so small that it cannot change the direction of the results.

With presentation scores, however, the case is different. With the first seven subjects the difference of 8.9 presentations for four series is in favor of the forced method and with the last seven in favor of the optional method.

Thus we find that:

TABLE 11

NUMBER OF PRESENTATIONS AFTER WHICH SYLLABLES OCCUPYING VARIOUS POSITIONS WERE ALWAYS CORRECTLY RECALLED (Group I)

Position	Forced Series A	B	C	D	Optional Series E	F	G	H	Forced Series A	B	C	D	Optional Series E	F	G	H
	Subject 1								*Subject 2*							
1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1
2	1	1	1	1	2	2	1	1	2	1	2	1	1	1	1	1
3	7	1	1	1	2	1	1	1	5	2	2	1	2	2	2	3
4	4	1	1	1	2	2	4	4	3	3	1	1	1	3	2	2
5	2	4	1	2	2	9	1	3	3	3	2	3	1	3	3	3
6	8	1	1	1	4	7	2	2	3	1	2	4	1	2	3	3
7	5	3	3	1	4	5	2	2	5	4	3	6	2	4	1	1
8	6	4	2	1	4	8	2	2	5	2	1	1	1	3	1	1
9	7	4	4	3	6	2	3	5	2	2	3	6	1	1	1	1
10	7	1	2	2	4	2	4	2	2	2	3	6	2	1	2	2
11	2	2	6	2	4	2	2	1	1	2	4	1	2	3	4	3
12	1	1	1	2	4	2	1	1	1	1	1	1	1	3	2	2
Presentations	8	4	6	3	6	9	4	5	5	5	4	6	2	4	5	3
	Subject 3								*Subject 4*							
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	2	1	2	3	3	2	1	1
3	3	1	2	2	1	1	2	2	3	1	1	2	2	1	2	1
4	4	3	1	1	3	1	1	2	3	1	1	1	3	3	2	1
5	3	5	2	2	1	3	1	4	3	2	3	3	2	1	2	1
6	6	1	3	3	1	5	2	4	3	3	6	3	5	4	3	1
7	7	2	5	5	2	4	1	4	2	1	4	7	3	4	3	1
8	2	6	4	4	4	3	2	3	3	2	4	3	5	5	2	2
9	7	5	2	2	1	3	3	4	3	3	1	4	5	3	3	3
10	3	1	5	5	3	1	1	2	4	4	3	6	5	1	4	3
11	3	2	2	2	1	1	3	1	1	3	2	1	6	1	1	3
12	1	2	2	2	1	1	1	1	1	3	1	5	2	1	2	2
Presentations	7	6	5	5	4	5	3	4	4	4	6	7*	6	5	4	3

*8 days after learning.

Subjects 1, 3, 7, 9, 11, 13, and 14 are clearly better with the optional method.

Subject 4 is probably better with the optional method.

Subjects 8 and 12 are better with the optional method but not significantly so.

Subject 6 is clearly better with the forced method.

Subjects 2 and 5 are better with the forced method but probably not significantly so.

TABLE 12

NUMBER OF PRESENTATIONS AFTER WHICH SYLLABLES OCCUPYING VARIOUS POSITIONS WERE ALWAYS CORRECTLY RECALLED (Group II)

Position	Forced Series E	F	G	H	Optional Series A	B	C	D	Forced Series E	F	G	H	Optional Series A	B	C	D
					Subject 5								*Subject 6*			
1	1	1	1	1	1	1	2	1	5	2	2	2	1	1	1	1
2	1	2	1	1	2	1	1	2	5	2	2	3	2	2	2	2
3	1	1	1	2	3	2	2	2	2	2	5	4	1	1	3	2
4	5	2	1	2	4	3	3	3	5	3	4	7	2	3	1	2
5	9	2	2	5	2	1	3	1	5	2	2	5	1	2	3	2
6	9	1	1	2	4	2	2	3	7	1	2	5	4	4	3	2
7	5	2	1	1	5	3	5	3	8	2	2	4	2	4	3	2
8	10	4	5	1	4	3	4	3	6	3	3	5	3	2	1	3
9	5	5	1	2	1	5	4	5	7	2	4	9	3	3	3	3
10	4	1	2	2	7	6	4	4	5	2	4	7	4	5	4	3
11	1	2	10	1	7	3	2	2	2	2	4	9	2	1	4	3
12	1	1	1	1	1	1	2	3	2	1	1	6	3	1	5	1
Presentations	10	5	10	5	7	6	5*	5	8	3	5	9	4	5	5	3
					Subject 7											
1	1	1	1	1	1	1	1	1								
2	1	1	1	1	1	1	1	1								
3	1	2	1	1	1	1	1	1								
4	1	2	3	2	1	1	1	1								
5	2	1	1	3	1	2	1	2								
6	2	1	1	2	1	1	2	2								
7	4	2	1	1	3	3	2	1								
8	4	3	1	3	2	1	2	1								
9	2	2	1	4	1	3	3	1								
10	3	2	5	4	2	3	3	2								
11	2	3	5	4	3	4	3	3								
12	2	2	5	1	1	1	1	4								
Presentations	4	3	5	4	3	4	3	4								

*10 days after learning.

Subject 10 is equal but probably better with the forced method.

To summarize:

Seven subjects learn better by the optional method.
One subject probably learns better by the optional method.
One subject learns better by the forced method.
One subject probably learns better by the forced method.
Four subjects learn equally well by either method.

TABLE 13

NUMBER OF PRESENTATIONS AFTER WHICH SYLLABLES OCCUPYING VARIOUS POSITIONS WERE ALWAYS CORRECTLY RECALLED (Group III)

Position	Forced Series				Optional Series				Forced Series				Optional Series			
	E	F	G	H	A	B	C	D	E	F	G	H	A	B	C	D
	Subject 8								*Subject 9*							
1	1	1	1	1	1	1	1	1	1	1	5	1	2	1	1	2
2	1	1	1	1	1	1	1	1	8	1	1	2	1	1	1	3
3	1	2	4	2	2	1	2	1	5	1	2	3	4	1	1	3
4	1	5	3	2	2	3	3	1	7	2	5	4	5	2	2	2
5	4	5	3	2	2	4	3	2	6	3	5	8	7	2	4	3
6	4	5	3	2	6	4	6	2	6	4	2	8	6	4	1	4
7	2	5	3	2	6	3	6	1	6	5	5	8	5	7	4	3
8	2	5	4	2	4	4	5	1	3	4	5	2	6	6	4	2
9	2	3	4	4	4	3	5	2	1	3	6	5	6	6	5	4
10	1	2	2	3	5	3	2	4	2	1	6	2	5	1	5	4
11	1	2	2	2	4	1	1	1	3	3	1	5	7	3	1	3
12	1	1	1	4	1	1	1	1	1	1	1	4	1	2	1	3
Presentations	4	5	4	4	6	4	6	4	8	5	6	8	7	7	5	4
	Subject 10															
1	1	1	1	1	1	1	2	1								
2	1	2	1	1	1	1	1	1								
3	1	2	2	1	1	6	2	1								
4	4	1	2	2	1	1	1	1								
5	2	1	5	2	1	1	2	1								
6	2	1	2	1	1	3	2	2								
7	3	2	3	3	3	2	4	2								
8	3	2	3	3	3	2	2	2								
9	1	3	3	5	3	3	4	2								
10	4	2	2	4	6	4	4	3								
11	4	3	4	4	5	4	5	3								
12	4	1	4	4	5	5	3	3								
Presentations	4	3	5	5	6	6	5	3								

Among these first seven subjects three (Nos. 1, 11, and 14) also did better by the optional method when scored by time. Table 17 shows that of these, Subject 1 shows a negative correlation between average time spent on each presentation of a syllable before learning with order of learning, Subject 11 a positive, and Subject 14 no correlation. There is clearly no consistency in these results. Table 15 shows that the length of the self-determined presentation interval offers no explanation of the difference.

TABLE 14

NUMBER OF PRESENTATIONS AFTER WHICH SYLLABLES OCCUPYING VARIOUS POSITIONS WERE ALWAYS CORRECTLY RECALLED (Group IV)

Position	Forced Series A	B	C	D	Optional Series E	F	G	H	Forced Series A	B	C	D	Optional Series E	F	G	H
	Subject 11								*Subject 12*							
1	3	1	1	1	1	1	1	1	2	1	1	2	1	1	3	1
2	1	7	1	1	1	1	1	4	3	1	2	1	2	2	1	2
3	1	1	2	1	1	1	1	1	3	1	3	2	2	3	2	2
4	5	2	1	2	2	2	3	1	1	1	1	1	3	1	2	2
5	3	2	2	3	3	2	3	2	1	2	2	1	1	2	1	1
6	5	2	2	4	4	3	2	2	2	3	4	2	3	4	2	1
7	5	5	3	4	4	5	5	4	3	2	4	2	1	3	3	1
8	5	5	2	3	5	3	6	3	3	2	3	1	3	4	1	2
9	3	4	2	6	5	2	6	4	2	3	6	2	2	2	2	1
10	3	1	5	8	3	1	6	2	2	1	3	3	4	1	2	2
11	2	8	3	4	2	3	2	3	2	5	2	2	1	2	3	2
12	1	3	3	8	1	2	1	3	1	2	1	2	1	1	1	2
Presentations	5	8	5	8	5	5	6	4	3	5	6	3	4	4	3	2
	Subject 13								*Subject 14*							
1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	3	1	1	1	1	1	1	1	2	1	1	1
3	2	1	2	1	4	1	2	1	2	3	2	1	1	1	6	2
4	2	1	2	1	4	1	2	1	1	4	3	1	2	2	4	3
5	3	1	4	2	4	1	6	4	1	4	2	1	1	2	1	5
6	2	2	8	2	6	1	5	4	3	2	1	3	6	1	1	1
7	7	4	8	2	4	1	3	1	2	2	2	1	5	4	6	3
8	6	3	9	2	5	1	1	4	4	8	2	1	4	3	1	6
9	8	2	9	6	4	2	3	5	4	3	5	4	4	2	4	5
10	7	4	3	3	8	3	3	4	4	4	3	5	5	1	4	1
11	8	7	2	4	2	3	1	6	3	4	1	3	1	1	2	2
12	4	4	2	3	3	1	4	4	2	1	1	2	1	1	2	2
Presentations	8	7	9	6	8	3	6	6	4	8	5	5	6	4	6	6

The data for relearning may be treated in the same way. Here we find the optional method superior on the basis of presentation with 10 subjects, inferior with three subjects and equal with one subject. Five subjects, Nos. 2, 3, 4, 5, and 6 find the optional method superior by both measurements, and one subject finds it superior by time measurement only. Comparison of these results with the correlations given in Table 18 show that of the five subjects who relearned better by the optional method, three have negative correlations, one a near zero correlation, and the other a low

TABLE 15

TABLE SHOWING TOTAL TIME AND TOTAL NUMBER OF PRESENTATIONS REQUIRED TO LEARN FOUR SERIES BY EACH METHOD (For Learning)

Also shows average presentation interval used by each subject. Time given in seconds.

Sub.	Pres. Opt.	Pres. For.	Time Opt.	Time For.	Opt. superior by Pres.	Time	Both	Pres. Interval Mean	M.V.	Group
1	51	57	501.9	684.0	x	x	x	.820	.081	1
2	46	40	565.1	480.0				1.054	.107	1
3	44	52	761.5	624.0	x			1.448	.232	1
4	45	44	636.2	528.0				1.200	.191	1
5	66	59	923.5	708.0				1.166	.131	2
6	64	37	909.2	444.0				1.187	.146	2
7	55	57	856.8	684.0	x			1.316	.236	2
8	37	46	623.0	552.0	x			1.410	.119	3
9	43	56	792.1	672.0	x			1.538	.184	3
10	48	48	538.1	576.0	equal	x		.938	.097	3
11	59	103	1049.6	1236.0	x	x	x	1.496	.212	4
12	25	34	521.9	408.0	x			1.797	.168	4
13	37	58	726.8	696.0	x			1.641	.213	4
14	59	71	792.4	852.0	x	x	x	1.130	.156	4

TABLE 16

TABLE SHOWING TOTAL TIME AND TOTAL NUMBER OF PRESENTATIONS REQUIRED TO RELEARN FOUR SERIES BY EACH METHOD (For Relearning)

Also shows average presentation interval used by each subject. Time given in seconds.

Sub.	Pres. Opt.	Pres. For.	Time Opt.	Time For.	Opt. superior by Pres.	Time	Both	Pres. Interval Mean	M.V.	Group
1	24	21	227.3	252.0		x		.800	.069	1
2	14	20	173.0	240.0	x	x	x	1.055	.120	1
3	16	24	277.4	288.0	x	x	x	1.438	.188	1
4	18	21	235.0	252.0	x	x	x	1.119	.113	1
5	23	30	299.9	360.0	x	x	x	1.103	.112	2
6	17	25	222.6	300.0	x	x	x	1.119	.127	2
7	14	16	200.6	192.0	x			1.217	.143	2
8	20	17	303.0	204.0				1.284	.140	3
9	23	27	393.8	324.0	x			1.448	.153	3
10	21	17	214.6	204.0				.869	.090	3
11	20	26	318.4	312.0	x			1.349	.191	4
12	13	17	270.3	204.0	x			1.844	.189	4
13	23	30	399.9	360.0	x			1.481	.231	4
14	22	22	278.9	264.0	equal			1.094	.149	4

TABLE 17

TABLE SHOWING THE CORRELATIONS BETWEEN THE AVERAGE TIME SPENT ON SYLLABLES BEFORE THEY ARE LEARNED WITH THE ORDER OF LEARNING

	For learning	
Sub.	Corr.	P.E.
1	—.48	.16
2	.09	.20
3	.64	.12
4	—.58	.14
5	—.64	.12
6	—.48	.16
7	—.02	.20
8	.44	.16
9	.22	.19
10	.86	.05
11	.94	.02
12	—.12	.20
13	—.62	.13
14	—.07	.20

TABLE 18

TABLE SHOWING THE CORRELATIONS BETWEEN THE AVERAGE TIME SPENT ON SYLLABLES BEFORE THEY ARE RELEARNED WITH THE ORDER OF RELEARNING

	For relearning	
Sub.	Corr.	P.E.
1	.21	.20
2	.04	.21
3	—.07	.21
4	—.06	.21
5	—.24	.20
6	.27	.20
7	.10	.21
8	.74	.10
9	.17	.21
10	.63	.13
11	.74	.10
12	.69	.11
13	.06	.21
14	.80	.08

correlation. Of these five who have high correlations none find the optional method superior when measured by time, two found learning superior by the optional method when measured by presentations, two found the forced method superior, and one found the two methods equal.

If the scores are combined to determine the method which re-

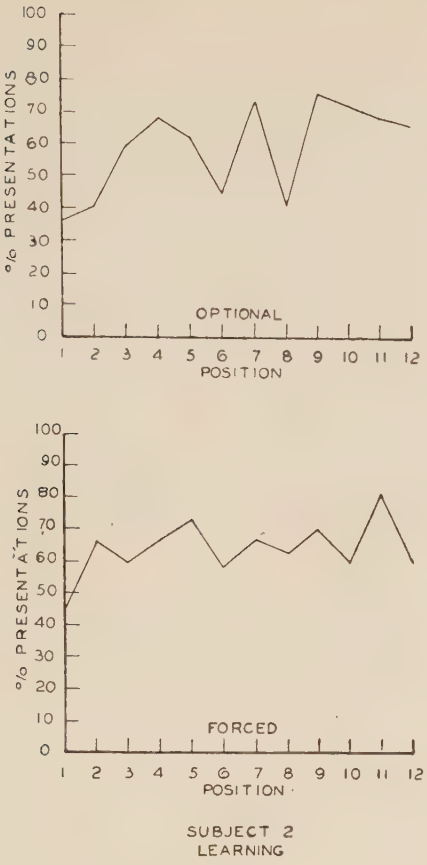


FIGURE 2

ceives the advantage in the arrangement of groups, we find on the basis of time:

First two series and last two series	244.98 sec.
Middle four series	290.21 sec.
Difference	—45.23 sec.

On the basis of presentation we find:

First two series and last two series	20.1 pres.
Middle four series	21.4 pres.
Difference	—1.3 pres.

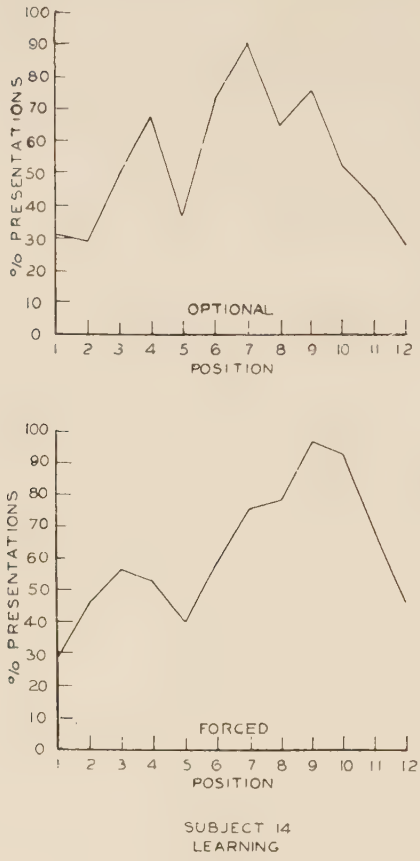


FIGURE 3

Here the end series are more easily learned than the middle, and the time difference is great, while the presentation difference is small, just the reverse of the corrections for learning, but the direction of superiority is not changed for either time or presentations.

The rank difference correlations between the correlations found in Table 17 and those in Table 18 is .47, *PE* ±15, showing that the correlation between the average time spent on each position and the order of learning the syllable occupying that position may vary greatly for learning and relearning.

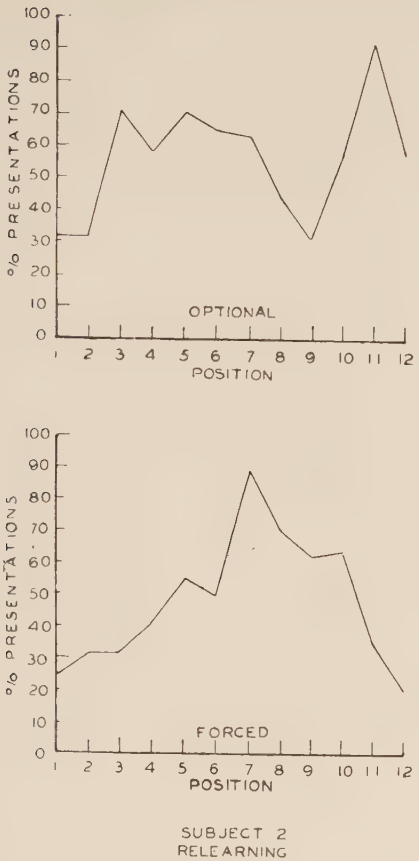


FIGURE 4

Comparison of Tables 15 and 16 shows that a subject's superiority under one method of presentation when measured by either time or number of presentations varies for learning and relearning.

F. General Discussion of Learning Experimentation

The results of all subjects taken together are not presented for the reason that the discussion of the results of the individual subjects shows that any total difference would indicate not a general tendency, but merely that by chance the differences which exist in both directions did not balance.

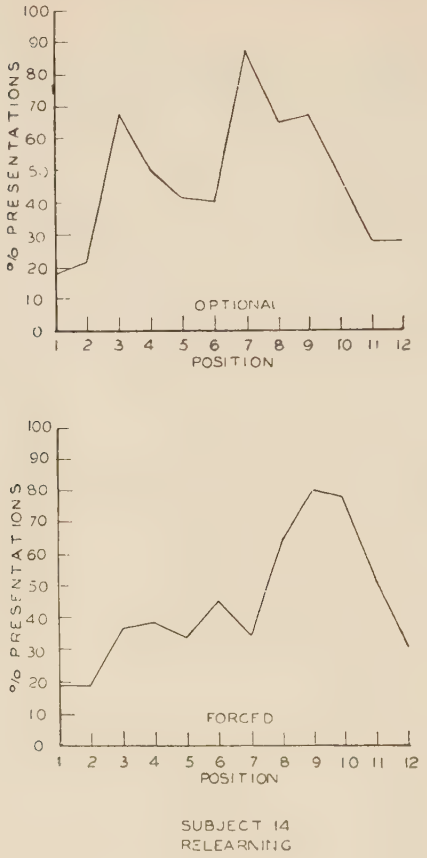


FIGURE 5

The use of total data, although justifiable statistically in learning experimentation, is not always justifiable in fact. It is statistically true that in any large group of subjects, some subjects will yield results of one sort, some diametrically opposite, and the others will yield results which lie between, but may not the results of these extreme subjects be more typical of these subjects than any "measure of central tendency" which does not adequately describe any subject?

It certainly seems to the present writer that the whole history of learning experimentation has shown a lack of true appreciation

of the necessity of an understanding of the exact results of the *individual* subject. The work of Ebbinghaus and the early German school, of course, was based on results obtained from too few subjects, but these were clearly analyzed and not buried in a series of averages, as are the results of most modern experimentation.

Other serious difficulties with our knowledge of learning are that results obtained by various methods under different conditions and with different materials to be learned are grouped and the resultant information is treated as if the elements making it up were comparable.

Experiments which have been done in the past have rarely been repeated by other experimentors, or if they have, it has been with conditions changed to such an extent that nothing is comparable. Leads given by experiments should have been followed up but have not been.

New material to replace nonsense syllables which have been proved inadequate is necessary, and we believe forthcoming. Such material should be standardized as to difficulty.

Among needed experiments, some of which have been started, are experiments to determine desirable speeds of presentation, to compare nonsense and meaningful material, to determine the difference between various methods of measuring learning itself. It is of particular importance that experimental work be done on the efficiency of various modes of presentation, as the educational application of this information is of extreme importance.

The present experiment needs to be duplicated, and further investigation of optional rates as compared with various forced rates needs to be made.

G. Conclusions

The influence of primacy, recency, and hence of intermediacy was found to affect the order of learning equally under both the optional and the forced method of presentation in both learning and relearning. Of the fourteen subjects, seven learned better by the optional method when scored by presentation, but only five when scored by time, and three found optional better by both methods of scoring. The data on average presentation intervals yielded no explanation of this finding. Corrections for group advantages did not significantly change these results. Of the fourteen subjects

ten relearned better with the optional method when scored by presentation, five by both methods of scoring, and one by time only. As with learning, no information was yielded by the data to explain this. Corrections for group advantages caused no significant change.

A subject who found one method of presentation superior for learning when measured by either or both time and presentation did not necessarily find the same method superior for relearning. There was no consistency in the relationship between the order in which the syllables occupying the various positions were learned and the average time spent by the subjects on one presentation of these syllables before they were learned. This lack of consistency was also evident when the time spent on each syllable after learning was considered. These same results hold for relearning.

References

1. Bingham, J. Memory (Studies from the Harvard Psychological Laboratory 11-B). (Communicated by Prof. Hugo Münsterberg.) *Psychol. Rev.*, 1894, **1**, 453-461.
2. Calkins, M. W. A study of immediate and of delayed recall of the concrete and the verbal. *Psychol. Rev.*, 1898, **5**, 451-462.
3. ———. Association. *Psychol. Monog.*, 1896, **1**, No. 2, 35-56.
4. Dorcus, R. M. A new control key. *J. Gen. Psychol.*, 1932, **6**, 492-493.
5. Ebbinghaus, H. Grundzüge der Psychologie. Vol. I. Leipzig: Von Veit and Co., 1905. Pp. 671.
6. ———. Memory. (Tr. Ruger and Bussemus.) New York: Teach. Coll., Columbia Univ., 1913.
7. Fineman, A. E., & Ruderman, S. Constant versus accelerated speed in learning. *Amer. J. Psychol.*, 1924, **35**, 261-263.
8. Finkenbinder, E. O. The curve of forgetting. *Amer. J. Psychol.*, 1913, **24**, 8-32.
9. Kühn, A. Über Einprägung durch Lesen und durch Rezitieren. *Ztsch. f. Psychol.*, 1914, **68**, 396-481.
10. Meumann, E. Psychology of Learning. (Tr. J. W. Baird.) New York: Appleton, 1913.
11. Robinson, E. S., & Brown, M. A. Effect of serial position upon memorization. *Amer. J. Psychol.*, 1926, **37**, 538.
12. Smith, W. G. The place of repetition in memory. *Psychol. Rev.*, 1896, **3**, 21-31.
13. Welsh, G. B., & Burnett, C. T. Is primacy a factor in association formation? *Amer. J. Psychol.*, 1924, **35**, 396-401.

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